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SEPTEMBER
1948

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By Carl Faessler

Universite Laval, Quebec, 1948
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Vol. III SEPTEMBER - 1948 No. 2

Contents

MIDWEST FEDERATION OF GEOLOGICAL SOCIETIES CONVENTION

The Chicago Rocks and Minerals Society was host to the member societies of the Midwest Federation of Geological Societies' 8th Annual Convention in Chicago, on August 21st, 22nd, and 23rd, 1948. The Federation now has sixteen member societies, with a combined membership of over 1500.

Among the lectures given on the 22nd were "Geology of the Chicago Area" by Mrs. Therron Wasson; "Pre-history and Geology of the Great Colorado Plateau" and "Canyons of the Southwest and Monument Valley" by Edwin Goff Cooke; "Grass Roots of the Geological Science" by Dr. Gilbert O. Raasch; and "Fluorite of the Kentucky-Illinois District" by Col. Fain White King.

On the 23rd, the members visited the world famous Strip-Mine area at Wilmington, Illinois, and collected fossil ferns under the guidance of Ben Hur Wilson and Frank Fleener.

A fifteen-page Convention Number of The Midwest Geologists, the official bulletin of the Federation, was published under the auspices of the Chicago Rocks and Minerals Society.

COVER PHOTO

The sand dunes at Nags Head, N. C., moving southward by prevailing wind action, leave thunderbolt nests exposed on their northern slopes. Gathering the heat-fused silica formations (fulgurites) created by striking lightning is a mean, painstaking, sun-burned job.

Read "He Chases Thunderbolts' for an interesting account of a fulgurite collector. "Foto by Hemmer", North Carolina Dept. of Conservation.

EXPLORING THE "MYSTERIOUS"

CHARLES E. HENDRIX
Boston University

To the average person, the word "cave" or "cavern" suggests something dank, noisome, and mysterious. Although the first two adjectives are not easily denied, it is the purpose of this article to eliminate the third to a great extent. Not entirely, of course, for each new cave explored presents features unknown before, but in general, when a little familiarity with caves and the natural processes at work in them is acquired, they become no more mysterious (and less dangerous) than the cellar stairs.

Most caves are limestone caves. Rarely is a cavern found in any other type of stone. Occasionally a lava flow hardens on the outside and the liquid lava inside flows away leaving a cavity, but it is not a true cave. Caverns are formed in limestone by the action of water in which carbon dioxide has been dissolved. This forms a weak solution of carbonic acid (H_2CO_3) which will attack and dissolve the calcium carbonate of which limestone is composed. Rain, in falling through the air, absorbs a certain amount of the carbon dioxide naturally present. When it strikes the ground it soaks down to the underlying limestone. There the insidious work begins. It runs into some crack caused by frost action or perhaps an earthquake shock and begins to enlarge it. There a cave is born. If conditions are right it may someday be another Carlsbad. Who knows?

If the water falls into a crack or hole in the limestone and there is no way for it to escape, nothing happens. The carbonic acid solution dissolves the limestone, but turns around and evaporates leaving the limestone where it was. Only when there is a chance for the water to flow is limestone transported and cave action accomplished. This is an important characteristic of limestone caves; there is **always** at least one inlet for the water and at least one outlet. They may not be easily identified sometimes, but exist they do, or did at one time, or there would be no cave. Caves have been known to fill up with water because their outlet became stopped up. Also caves become dry and "dead" when their inlet is no longer open.

Besides the dissolving action of the water there is another important action, that of building. It often happens that water laden with dissolved calcium carbonate has a chance to evaporate, leaving the solid limestone behind. For instance, a drop of water on the ceiling of a cave evaporates before it falls, leaving a tiny bit of limestone behind it. This becomes the nucleus upon which an icicle-like stalactite will form, providing enough other drops of water do the same thing at the same place. More will be said about these and other built up formations later.

Associated with caves as allied phenomena are sinkholes, "lost" rivers and certain springs. Sinkholes are places where surface water regularly enters a cave. They are usually bowl-shaped depressions in the earth varying

from a few yards to a quarter mile or more in diameter, and in depth from a few inches to fifty feet or more. The shallow ones usually have no visible opening at the lowest point. This means the seepage of water into the cavern below is very slow. Other sinkholes may have at the center a large vertical shaft which opens directly into the cave beneath. Like all cave phenomena, sinkholes vary enormously in degree and size but are all alike in the function of channeling surface water into the caves. Whenever they are found you can be sure that cave action is going on, although there may be no large cavern. It may still be very young and small. At the same time, however, caves can exist where there are no visible sinkholes.

Since a prerequisite for cave formation is a place for the water to run **in** and a place for it to run **out;** we can always be sure to find an outlet in the vicinity of a sinkhole. This outlet will not be below the local natural water level unless this has risen (due to damming of rivers, etc.). This outlet will either be a spring or a cave. The flow may be large or small, continuous or intermittent, depending on the amount of rainfall and the size and number of the inlets. Not all springs are of cave origin, however. In some of them water is carried in a layer of gravel or between cracks in rock other than limestone. A true cave-spring flows from a hole in limestone and will probably "grow up" to be a large cave.

The belief that all spring water is safe to drink is not at all tenable; for there may be a very direct path between some sinkhole where polluted surface water enters and a cool, woodland spring. Nor is clear water necessarily an indication of safety for it may have large numbers of bacteria without having any solid suspended matter. It is always best to have a bacteriological examination of springs that are to be used for drinking water.

The extreme case of the sinkhole-spring connection is the so-called "lost-river", where a surface stream plunges into a sinkhole and reappears some distance away.

Many caves are found that have no water running in them. Some few are dry and dusty. In these the inlets are no longer open and they have ceased to be a drainage channel.

No two caves are ever alike but they do seem to fall into a few definite patterns which are listed here. No doubt other types exist however.

Since a cave is essentially a water course it is natural to expect to find them in the shape of a river. Water enters through many small sinkholes and small rivulets converge to form larger streams which converge again and again until the main stream emerges at the mouth of the cave. Most of the tributaries will be too small to pursue to their source. Occasionally the head of such an underground river will be found to be a large room with the water inlet through a small opening or crack in the ceiling. This type of river system-like cave is usually found where the rock-strata is horizontal or nearly so. The cave is found to lie almost entirely in a soluble layer. If the soluble stratum is thick or if there are several separated by less soluble layers, the cave may in time develop several levels. The lowest will not be below the natural water table, however. The many caves of Missouri and Arkansas are mostly of this type. (See Fig. 1).

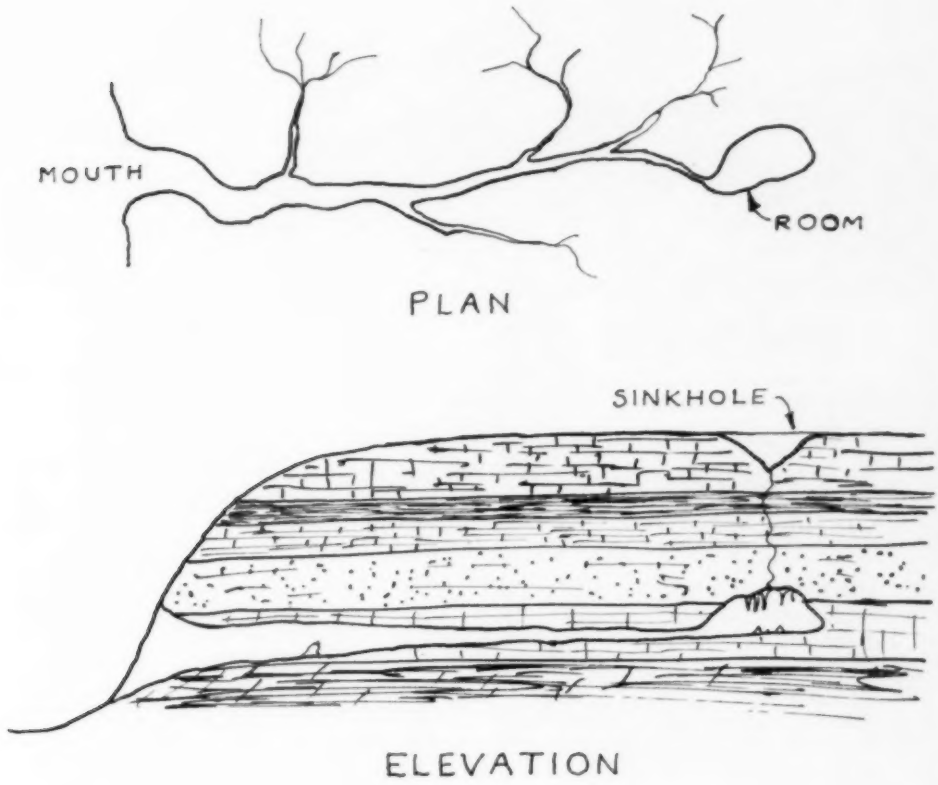

Fig. 1. The river system type of cave.

Contrasted with the above type found in level strata, the caves found where the strata are sharply tilted are entirely different. Here the water, instead of filtering down through the overlying rock layers until it finds a soluble stratum, enters the soluble layer directly where it is exposed at the surface. The caves in this type of region are characterized by a large inlet, tapering, with many ramifications, to a small outlet at the bottom. They are usually more complex in form than the river system type of cave, however. The inlet is very often found high on the side of a ridge and the outlet in the valley below. Probably the reason the cave is larger at the top than at the bottom is because there is a complete reaction with the carbonic acid in the water as soon as it comes into contact with the limestone. In other words, the concentration of carbonic acid gets smaller as it trickles downward, and the dissolving action is smaller in the lower reaches of the cave. High waterfalls are often found in caves of this nature. The general form of this type is illustrated in Fig. 2. The caves found in the limestone ridges of the southern Appalachians are mostly of this type.

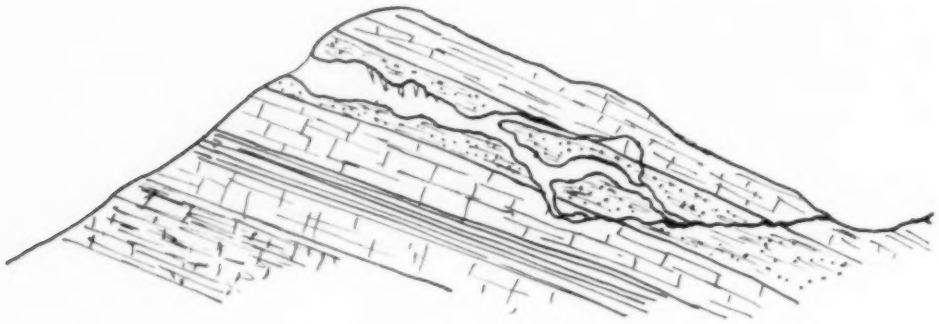

Fig. 2. The cave associated with tilted strata, characterized by a large inlet, tapering, with many ramifications, to a small outlet at the bottom.

A third kind of cave is probably a "descendent" of the river system type. It is the "tunnel" cave. Here a surface stream runs under a hill through a natural tunnel. Perhaps the origin of these caves may be explained by the collapse of the roof of part of a river system cave. The Natural Bridge in Virginia is thought to have been formed in this manner, except that here all but a small portion of the roof has disapeared. The Maquoketa Caves in Iowa are of this type. Also, at the head of the Sequatchie River in middle Tennessee there is a boxed in valley of several hundred acres whose only drainage is through a cave of this type. Supposedly it discharges into the Sequatchie River, proper. (Fig. 3 illustrates the general type.)

All of the caves mentioned so far have had one thing in common. They are essentially a watercourse. There is one rare type of cave which does not seem to be such. It may actually be, but it is not readily observable. It is characterized by narrow, high passages that often intersect at nearly right angles, forming a "city block" structure. Apparently they are formed by water action enlarging cracks or fissures in the limestone. Possibly the cracks were originally opened by an earthquake shock, although this is mere conjecture; there being many other explanations for cracked rock. Since the cave follows these original fissures, no watercourse is readily apparent. There is usually no definite "floor" to these caves; the passage simply gets narrow at the bottom. In many places it gets filled up with rubble but it is not a true floor. This characteristic might indicate that most of the water flow was vertical with the tapering due to the depletion of carbonic acid content mentioned before.

It is apparent that such a cave is the most dangerous to enter. Many passages intersect at right angles so that one intersection looks much like another, which proves to be extremely confusing. Also the lack of a definite floor provides many pitfalls. It is this type of cave that Mark Twain wrote of in "The Adventures of Tom Sawyer". It is a well known Hannibal, Missouri landmark. The type of cave is illustrated in Fig. 4.

Of course, the types mentioned may be found to be modified or

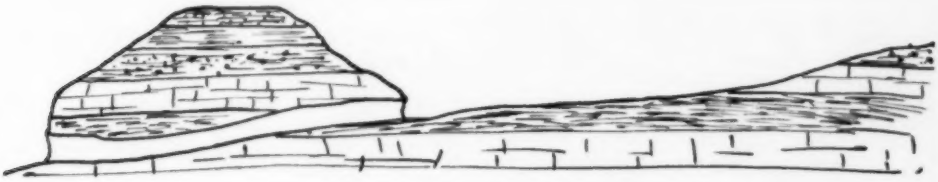

Fig. 3. The "tunnel" cave.

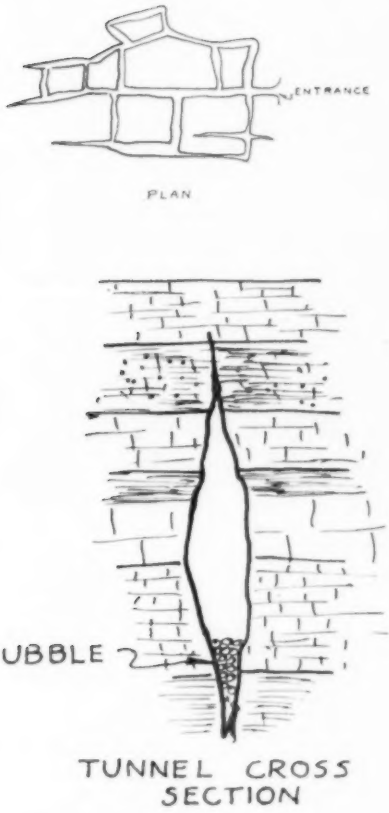

Fig. 4. The fissure type of cave, characterized by narrow, high passages that often intersect at nearly right angles.

combined in many caves. There is no hard or fast rule governing the shape of any cave—only a collection of a great many unpredictable factors.

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GREAT MASSES OF STARS WERE FORMED WHEN EARTH WAS A TENTH AS OLD AS NOW

COLUMBUS, OHIO, July 28—When the universe was a tenth as old as it is now, the great masses of stars called the galaxies (like our Milky Way) were formed.

It took that time, 300,000,000 years, from the beginning of things for the universe to evolve into the general shape that it now is.

This new view of the past life of the cosmos has been figured out by Dr. George Camow, mathematical physicist of the George Washington University, Washington, D. C., author of "Biography of the Earth" and other books, who is lecturing here.

A few months ago Dr. Gamow joined in fixing the original temperature and density of the expanding universe when it was a few minutes old. In the beginning, all creation was a highly compressed gas made up of neutrons (now best known as the trigger of atomic bomb fission.) This gas (heavy as iron) started decaying into protons and electrons and building up the heavier chemical elements. The stuff of the universe was completely made in about one hour.

Now Dr. Gamow is following the expansion of the universe further. Starting with these initial conditions and the correct proportion of the various kinds of atoms that were "cooked" at the beginning, he finds that the size and mass of great clouds of stars can be calculated from the initial conditions. And since the universe got into its essentially present shape, nine times as much time has elapsed as was necessary to create the galaxies.

NEW SYNTHETIC MICA SEEMS SUITABLE FOR ELECTRONIC APPLICATIONS

WASHINGTON, July 31,—Man-made mica, with the electrical characteristics of natural mica, is now being produced in the United States, it was revealed today by the U. S. Army and the Navy. Both had a hand in the research program which developed the new synthetic product.

Great quantities of mica are required in America each year in many types of electrical equipment, particularly in condensers and other circuit elements. It is used in large amounts as insulation in electrical machinery and as a dielectric in electronic circuits. It plays a big part in radio and radar. No domestic deposits of suitable mica have yet been found in America large enough to meet the needs. The volume supply in the past came principally from India and Brazil. The new synthetic may make further importation unnecessary.

The interest of the Army and the Navy in the development of a mica substitute is due to the fact that both are large users of this material in their communications and other equipment. They rate mica as a strategic mineral, one necessary to stockpile for future emergencies if there were no substitute.

Known as fluorine-phlogopite mica, the new synthetic is now being produced on a pilot-plant scale. It has the desirable characteristics of natural mica, including perfect cleavage into thin sheets, good electrical and mechanical properties, and chemical stability. It is expected to replace the muscovite and phlogopite forms of natural mica, the silicate minerals that the United States has been importing in large quantities.

Considerable work has been done in the past few years looking toward the development of a synthetic mica or a mica substitute. Government-sponsored research on mica synthesis was initiated at the Colorado School of Mines in June, 1946, under an Army Signal Corps contract. Later the U. S. Bureau of Mines began synthetic mica pilot-plant work at Norris, Tenn., under a contract with the Office of Naval Research. Owens-Corning-Fiberglas Corporation, serving under a consulting contract, furnished accumulated information gathered in two years of research, in 1945-46, in a mica synthesis program. Other groups also assisted.

RELICS OF EARLY INDIANS UNCOVERED BY ARCHAEOLOGISTS

WASHINGTON, Aug. 1 — Pottery fragments tempered with fiber, which apparently represent the birth of the ceramic industry among the Indians of the southeastern United States, have been uncovered by archaeologists from the Smithsonian Institution here.

These broken pieces of pottery, which are an important archaeological find, were discovered when explorations along the Savannah river in Georgia and South Carolina revealed what must have been a popular Indian camp for perhaps a thousand years.

Indians, from the prehistoric mound-builders to the Creeks who lived in the area just before the coming of the white men, chose this site for a home and left behind them the traces of 150 habitation sites which are now being scientifically investigated for the first time. The Savannah river sites have been neglected by archaeologists until now, when parts of the area will be flooded in the construction of the Clark Hill Reservoir.

A survey of the region is being carried out as a cooperative project between the Smithsonian Institution, the National Park Service and the Army Corps of Engineers. Carl F. Miller and Joseph R. Caldwell of the Smithsonian staff are working to find and mark archaeological sites for possible future excavation before the reservoir is completed and flooded.

CHINA'S "DAWN REDWOOD" MAY BE ANCESTOR OF AMERICAN REDWOOD

BERKELEY, Calif., Aug. 2 — China's "dawn redwood", Metasequoia, may turn out to be not only a "living fossil" but a "surviving ancestor" of the well-known American coast redwood, Sequoia sempervirens. This possibility has developed from an effort by Dr. G. L. Stebbins, Jr., of the University of California to settle the rather puzzling relationships of the recently discovered Chinese tree, hitherto known only as a fossil species.

In characters visible to the naked eye, the dawn redwood resembles the coast redwood more than it does any one of a half-dozen other related conifer species, among which are the California big tree and the bald cypress of the South. However, it has points of difference with the coast redwood, and similarities to some of the other trees.

The study developed the interesting suggestion that the coast redwood, unlike all its kin-trees, may be a hybrid. This idea comes from an examination of the heredity-bearing chromosomes in the cell nuclei. The coast redwood appears to have a basic count of 66 chromosomes, as compared with 22 in most of the other related species. Multiple chromosome numbers always suggest hybrid origin to plant scientists.

Metasequoia, the dinosaur-age direct ancestor of Metasequoia, seems a likely candidate for ancestral honors on at least one side, Dr. Stebbins believes. The other half of the coast redwood's family tree remains to be discovered.

EARLIEST AMERICAN HOUSE MAY HAVE BEEN FOUND IN SOUTHERN CALIFORNIA

LOS ANGELES, Aug. 4 — America's oldest house, with a possible age ranging from 10,000 down to 3,000 years, may be represented by an enclosing rectangle of post-holes discovered near Little Lake in Inyo County, Calif., by an expedition from the Southwest Museum here. Actual find was made by a volunteer amateur archaeologist, B. E. McGown of San Diego.

There are 23 holes, averaging four inches in diameter, outlining what seems to have been a crude hut about eight by 12 feet in size. The posts stood upright, so it is assumed that they supported a roof. No hearth has been found in the enclosure, but near the southwest corner is a depression containing many charred and split bones of food animals. The floor was of packed earth.

M. R. Harrington, curator of the Southwest Museum, who was in charge of the expedition, states that the dwelling may date from shortly after the close of the Ice Age. Stone spear or dart heads of the type recently named Pinto Basin culture were found in and near the old house site, so there is no doubt that Pinto Basin man built and lived in the hut.

Date of the Pinto Basin culture, first discovered near Twentynine Palms, Calif., by Mr. and Mrs. W. H. Campbell, has not yet been established. Estimates range from as recent as 1,000 B. C. to as ancient as 8,000 B. C.

Earliest American habitation, aside from caves, are pit dwellings dating from the earlier centuries of the Christian era, when the Basketmaker culture flourished in the Southwest.

WARTIME AIRBORNE MAGNETOMETER DETECTS POSSIBLE OIL FORMATIONS UNDER WATER

WESTCHESTER COUNTY AIRPORT, N. Y., Aug. 4 — The inner workings of the wartime "doodlebug" pest to German U-boats in the Atlantic were revealed here today by the Gulf Oil Corporation to a group of science writers. Its application to oil surveys was also demonstrated.

Its proper name is the magnetometer. It is a device housed in a bomblike structure which is trailed behind and below an airplane. Its delicate magnetic instrument reacts to magnetic influences below, even to a submarine concealed deep in the ocean. It was used during the war, and since, to locate hidden iron ore deposits. Its greatest use today is in search for petroleum, even oil under swamps and in the ocean bed.

It has already been used in many surveys for oil, including an 85,000-square-mile area of the continental shelf in the Bahama islands where other scientists, working under giant diving bells, used gravity methods. The magnetometer method is now being used to explore a great tract in Africa with American planes and American instruments. Many other surveys have been made over dry land and almost inaccessible swamps. One great value of the magnetometer is its ability to survey hard-to-get-at areas, and do it with great speed.

The magnetometer reacts to the earth's magnetism in addition to iron and steel objects and to deposits of magnetic ore. As explained by Gulf scientists, the earth's magnetic field varies in intensity. The variations of importance in oil explorations are those caused by differences in composition and proximity to the surface of the magnetic igneous rocks which comprise the underlying or basement rock found in all areas.

When the structural configuration, or form, of these basement rocks is such as to bring them relatively close to the surface, a magnetic high area will be indicated by the instruments. Thus, by the variations in these magnetic measurements the geophysicists secure information which permits them to make a contour map, which shows variations in the composition and structure of the earth's basement rock.

The overlying sedimentary rock may reflect a similar configuration, which can indicate the existence of geological conditions permitting the accumulation of oil.

The heart of the magnetometer is a magnetically sensitive element about the size of a cigarette. Its findings are transmitted to the instrument in the plane through the trailing cable. The airborne magnetometer's success is due in large part to its ability automatically to orient itself at all times so that it is in perfect alignment with the earth's magnetic field.

GAS TURBINE, ONCE RUSSIA-BOUND, ENTERS PULVERIZED-COAL-BURNING TESTS

WASHINGTON, Aug. 5—Two American gas turbine engines, one of which was once destined for Russia under the lend-lease program, are now to be used in this country in conducting two notable experiments in the coal-burning field.

The first is in connection with the use of pulverized coal as a fuel for gas turbine locomotives. The second is in the use of gases for fuels which are obtained by burning underground thin layers of coal just as they occur in nature.

These two gas turbines now belong to the U. S. Bureau of Mines. They were obtained from the War Assets Administration after being declared surplus by the State Department. The one which was to be shipped to the Soviet Union is a 40,000-cubic-feet-per-minute unit. The other is a 23,000 c.f.m. turbine, and it is this one which will be used with the underground burning of coal experiment.

The gas turbine engine, now becoming more popular in America and other countries because of its efficiency, is similar to the steam turbine but utilizes gases of combustion under high pressure against the vanes on the shaft of the engine to cause its rotation. High-pressure steam is used in the steam turbine. One great advantage of the gas turbine is that it requires no water. Therefore it can be used where water is scarce, in desert country and in mines, and it can be used in locomotives.

The larger of these two units is to be located at Dunkirk, N. Y., in a laboratory of the Locomotive Development Committee of the Bituminous Coal Institute. Scientists of the organization, working at Baltimore and using funds provided by a group of American railhave already successfully used pulverized coal as fuel to operate a gas turbine. Two locomotives are now under construction which will be powered by coal-burning gas turbines. The use of this turbine will further the studies of the scientists.

The experiment in burning bituminous coal as it occurs in underground seams is being conducted at Gorgas, Ala., by the U. S. Bureau of Mines and the Alabama Power Company in collaboration this year for the second time. Holes are drilled down through the coal seam, and an incendiary is dropped into one. Constant air pressure is then applied to support combustion. Gases formed are recovered from the other drill holes. They are suitable for firing a furnace or can be used to make synthetic liquid fuels.

LABORATORY-GROWN QUARTZ CRYSTALS MAY INCREASE SUPPLY OF VITAL MATERIAL

Cambridge, Mass., Aug. 5 — Quartz crystals, grown in the laboratory, may add to the supply of these crystals which are vital to radio communication and electronic apparatus.

These crystals are used in radio transmission and long-distance telephony because they can convert mechanical energy such as sound waves into electrical energy — and back again. During the war, tiny wafers of quartz, smaller than a postage stamp, were used to control the frequency of military radios. In the past this country has imported most of its raw quartz from Brazil.

Ernest Buehler and Alfred C. Walker of the Bell Telephone Laboratories told the International Congress of Crystallography at Harvard University here how they had been able to produce quartz crystals more than an inch long in a month. They placed silica and a small quartz crystal in an alkaline solution inside a steel bomb. The bomb was then heated to 750 degrees Fahrenheit at a pressure exceeding 15,000 pounds per square inch.

Crystals producted in this way are not substitutes. They have the same composition as quartz found in nature. Since they are grown under specially controlled conditions, they even tend to be superior to most natural crystals.

Experiments have been so successful, the Bell scientists said, that commercial production of quartz crytals in the near future seem likely.

Danforth R. Hale of The Brush Development Company of Cleveland told of experiments in which silica, a small crystal of quartz and water were placed in heavy pressure vessels at a pressure of several thousand pounds per square inch and cooked at a temperature close to that of a very hot flat iron. In one of these experiments the small crystal increased in size 12 times in about 60 days.

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THE COLLECTOR

This section of the Earth Science Digest is devoted to the collector of minerals, fossils, and rocks. Notes on collecting, collections, localities, etc., will be welcomed. Please address all correspondence to The Collector, c/o The Earth Science Digest, Revere, Mass.

HE CHASES THUNDERBOLTS

E. CARL SINK

George Franklin Hill, Jr., of Raleigh, North Carolina, is both a commercial artist and a lechatelierologist. He is only one of many thousands of commercial artists, but he happens to be the only lechatelierologist in the world, since he invented the title for himself.

Just to look at Hill is enough to convince one that he is "something no one else is." Perhaps it has something to do with the gem stone in his large silver ring — that's no ordinary stone, brother — it's a fragment of the moon, and we have this on no less authority than that of the astromomer Dr. H. H. Nininger himself. This unique gem is a part of Hill's study of lechatelierology.

Nothing objectionable, lechatelierology denotes a little-known branch of mineralogy. And mineralogically speaking, lechatelierology is the study of naturally occurring amphorous twice-fused quartz silicates, but reduced to unglamorous English, it is merely the study of melted sand. Only a watcha-call-it could find anything but boredom in its technical finer points, but the subject from the broad point of view would intrigue anybody. In the first place only lightning, falling meteors (his gem stone is of this type), and atomic bombs produce sufficient heat to melt this silica — so these are the only agents which can form lechatelierite. It is, therefore, nearly as scarce as hen's teeth.

Hill's pursuit of this study has netted him a priceless collection of lechatelierite that bids fair to be the most complete in the world, and he is now unquestionably the world's authority on the subject. He's spending his rainy weekends finishing a book on the subject, but don't look for it on any drugstore bookshelf; it's strictly for the initiated. While most meen seek artistic pastimes as outlets for their creative urge, Hill chooses this exact science. His vocation and avocation are exactly the reverse (and envy) of the rest of us —his creative urge is satisfied on the job, while his calculative work is put into his science hobby.

Happy hunting grounds for his specimens are the golden sand dunes of Dare County, North Carolina, from whose 100-foot summits the air age began in 1903 and which now form a monstrous backdrop for the 20 miles of beach colonies of Nag's Head and Kitty

G. F. Hill examining his collection of Nag's Head, N. C., fulgurites.
—North Carolina Dept. of Conservation

Hawk. Here Hill digs the scars from old Vulcan's fire-crackers.

Heres' what happens: Lightning blasts a bolt straight into the ground, fusing a gray, tapering, glassy shaft as it goes. Sometimes the shaft extends down over 30 feet; Hill can't account for any depth below this—it's pretty tough digging soft sand in the broiling sun, you know. These delicate shafts are called fulgurite from the Latin **fulgur,** meaning "lightning" It is the most common form of lechatelierite — but plenty rare enough for Hill to be able to name his own price from museums around the globe for specimens of it. Far from being johnnys-come-lately, these shafts can be proved by reconstruction of the topography to have an average age of 250 years.

Hill says he hopes but never expects to be lucky enough to excavate a shaft while it is only seconds old and still hot. "Hopes," he says! Such carryings-on might well reduce Hill himself to a fulgurite shaft if the fickle lightning should ever haul off and strike a second time in the same spot!

Eastern North Carolina's beach country is quite unique in this respect. Besides the eastern Carolina shores, only the shores of Lake Michigan and the sandy San Clemente Island off the southern coast of California have this claim to fulgurite fame. It takes a very remarkable coincidence of many geologic factors to cause land to be fulgurite-fertile.

An interesting thing, though, is that these thin-walled fulgurite shafts are hollow; this is due to the nature of electricity itself, and it has been demonstrated that electricity travels cylindrically only on

Fulgurite specimens from San Clemente Island, off California, and Lake Michigan, only other specimen grounds discovered.
—North Carolina Dept. of Conservation

the outside surfaces of wires and other conductors.

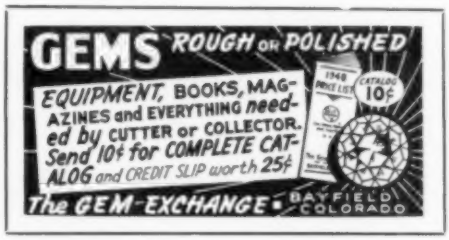
Every summer Hill, the lechatelierologist, roams the dunes in search of specimens and further knowledge about them. Time was when his friends were able to accompany him. Now he takes his strides pretty much alone. Nature guards this treasure well. It does take a powerful lot of hill-climbing, miring through quicksand, and mosquito-swatting to reach the place, and then (if he locates a shaft) the sand-papered, sensitive fingers of a safe-cracker and the patience of Job to dig it up. Companions fall behind, then drop out like flies.

In Hill's collection one may view other types of lechatelierites, including green fused earth from the first atomic bomb, splashes of fused sandstone from the Great Arizona Crater and other meteorite craters, fragments of the moon, and even rarer forms. The moon fragments are a story in themselves, but briefly Hill explains that the moon, having no atmosphere to produce friction, catches the full impact of falling meteorites and, since there is little gravity to hold down the pieces of the moon thus dislodged, they are blasted off into space, and a few have been known to reach the earth in the form of small black pebbles of fused silicate.

Lechatelierology isn't a study of the art-for-art's sake variety—it really pays off. He markets this material all over the globe, like the advertising man that he is, and the value of his findings is reflected in the avowed eagerness of the men in mineralogical and electronic professions for the completion of his study. But as rare and as eagerly sought as lechatelierite is, it has no commercial use, and therefore, no commercial value. It's only the knowledge of the geologic and electrical sciences that can be gleaned from these findings that make it worthwhile. It's like a dinosaur bone—of no earthly value but to science, and, of course its display value in museums.

To all would-be fulgurite sleuths Hill gives this solemn warning: if you go prepared with shovel and basket, you will find nothing; but if you go with no equipment for digging and no conveyance for bringing specimens home, you will usually get results. He has no scientific explanation for this—he just calls it "cosmic law."

(State News Bureau, Raleigh, N. C.)



Letters To The Editor

Dear Sir:

I like the Earth Science Digest very much and would not want to miss a single copy. Keep up the good work and may all success come to you.

P. J. Enden
Garden Home, Oregon

Dear Sir:

The Earth Science Digest is a much needed magazine and I hope it has a good future. I would like to see it keep up a little more on American Anthropology.

Elmer O. Dahl
St. Paul, Minnesota

Dear Sir:

Received my issue for July and want to compliment you on the pictures of the Denver Convention. I take all the mineral magazines but yours was the only one that took the trouble to put any pictures in which shows that you are interested in the subscribers as well as the advertisers.

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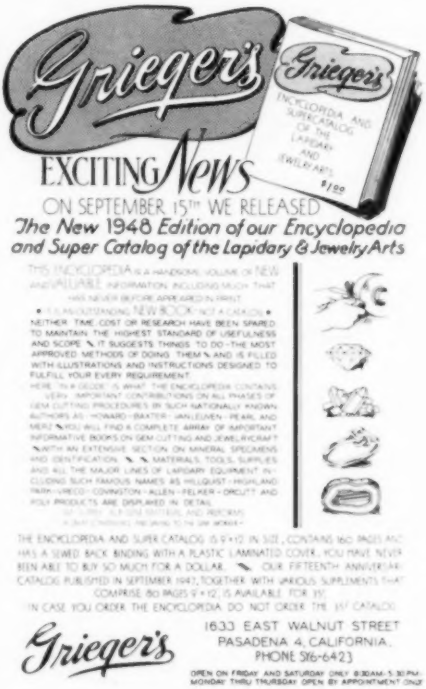

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Harold P. Merry.

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THE DWARFING OF INVERTEBRATE FOSSILS

RICHARD L. CASANOVA

For many years the dwarfing of fossil invertebrates has been a study of great interest among amateur and professional paleontologists alike. Some paleontologists believe that dwarfing is due to biological degeneration, a natural tendency in certain animal groups to become dwarfed. Others believe that dwarfing is due to other causes, not necessarily brought about by geologic or biologic factors.

A study of cephalopod and pecelypod genera and species, with particular consideration to such dwarfed faunule as appears in the Comanchean Series of the Lower Cretaceous of Texas and Oklahoma, has shown that dwarfing as a biologic reaction can be brought about through existing environmental conditions and causes.

In my opinion, the direct cause of dwarfing among the abundant fossil invertebrate fauna of the Comanchean of Texas was a chemical reaction. A heavy precipitate of lime or iron sulphide, being carried in solution affected certain genera, species, and even entire groups, within certain geographic limits.

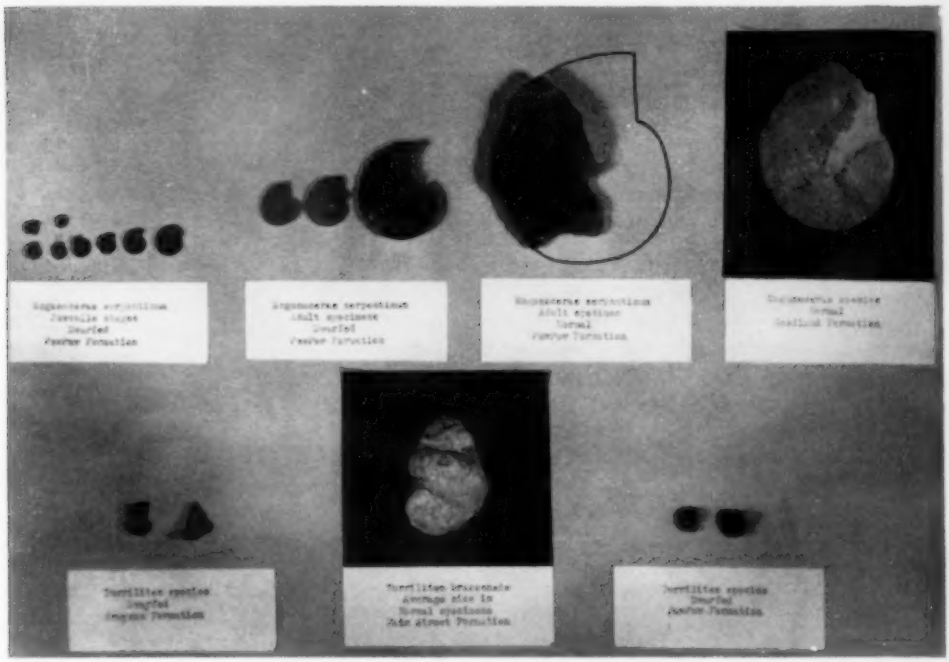
It is believed by many that the occurrence of a dwarfed fauna in any geologic horizon was due to such chemical precipitates. As already mentioned, such could be an excess of lime, or iron in solution, or the tendency of lime to form oolites in certain bodies of water at the time of deposition. However it must be remembered that where a genus is dwarfed, not all the fanule-facie found in that deposit need be dwarfed.

The prevalance of dwarfed specimens will however preclude the supposition that dwarfing is nothing less than the prevalence of juvenile forms of normal specimens. If such were the case, these undeveloped specimens would be included in a mixed fauna. Such a case is not typical among the ammonoidea, where a study of suture, coiling, etc, tends to show that a dwarfed type is equivalent to a mature type of any normal fauna.

Dwarfed faunas are known to occur within the Paleozoic; particularly among the cephalopoda and gastropoda. But so far as I have learned such dwarfed forms never occur in association with a normal fauna, with one possible exception.

At Falls Brook, a few miles south of Geneseo, New York, in the Tully pyrite zone, which separates the Middle (Hamilton group) and the Upper Devonian rocks, occurs an abundant dwarfed fauna. It is believed that the Tully pyrite was deposited in a partially land-locked sea, as evidenced by the presence of ripple marks and sun cracks which occur in the rocks. While this pyrite fauna appears to be 80 per cent dwarfed, the remaining 20 per cent are normal-sized specimens. These, as is the case with forms appearing in the Cretaceous of Texas, probably drifted in from the open sea.

The completely pyritized specimens of the Tully formation tend to show that the Tully sea carried much iron in solution, and that the shallow sea-bottom, being littered with decaying organic matter, released hydrogen sulphide. It was



A series of cephalopods from the Comanchean division of the Lower Cretaceous of Texas, showing types of dwarfed specimens in relationship to normal forms.

these two chemical reactions which brought about the dwarfing of this particular fauna.

The warm seas of Comanchean time advancing from the southwest, appear to have been extremely favorable for the growth and continued evolution of certain faunas. Such a faunule, as represented by abundant pelecypods, brachiopods and echinoids, found these warm shallow water zones favorable for breeding, as shown by the extensive beds of these fossils. It is common knowledge that every marine animal selects a particular type of bottom or depth-level which is best suited to it. In many cases such acceptable areas are selected as breeding zones. From such zones each genus and species will spread out as far as its environment will permit, or as long as it can adapt itself to such changing environmental conditions as it may encounter. An example of this is the migration of the ammonoidea which are capable of feeding while drifting across large bodies of water. Many ammonoid genera drifted across epicontinental seas, and thus may have passed from one geologic horizon into another without much genetic change.

On the other hand, a fauna accustomed to relatively shallow seas would not be capable of surviving at greater depths. Such changes as lowered temperatures, increased pressure, and scarcity of food are all against the survival of non-migrating faunas.

Another change to consider in speaking of dwarfing is that brought about by conditions arising from land barriers which would restrict certain biologic groups to definite geographic areas. The formation of such land

barriers would to a great extent cut off normal supplies of food, and warm-water, and create polution by depositing vast quantities of land sediment.

Finally, a continued dumping of land washings and mineral precipitation into such neritic zones would be a very great factor as a cause of dwarfing, if not tending to totally wipe out the marine fauna.

The ammonoid genus **Engonoceras** of the Cretaceous of Texas and Oklahoma, which is a relatively common form, clearly illustrates that dwarfing throughout Comanchean time was brought about by environmental conditions. This genus which extended stratigraphically from the PawPaw to the Goodland formations, show that only adverse environmental conditions could have possibly brought about genetic degeneration throughout its widespread stratigraphic range. The smaller, coiled ammonoid, **Turrilites,** is a case where forms of two or more types appear as different species, sometimes called varieties, but which actually have been found to have been separated merely by superficial differences. Such differences may have been brought about by environmental conditions.

A final example of the results of dwarfing which may be considered as due to such environmental conditions as explained above, is the Indiana limestone. Here, reeflike bodies of limestone, usually oolitic, may be seen to extend over wide areas. While this limestone may be found to contain nothing but dwarfed animals, it will merge on all sides with shales and other limestones of apparently the same age, but with normal sized faunas.

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Africa has for centuries exerted on men's minds the fascination of unsolved mystery. It was so to the Greco-Roman world of antiquity, to which Ethiopia meant Farthest South; it was still so to our own grandparents of the mid-nineteenth century, who thrilled to the unknown when they uttered their favorite geographical cliche, "Darkest Africa."

Much of the darkness has been dispelled from over the great continent. You can go to the railway station in Cairo and buy a through ticket to Capetown; airplanes droning over the Congo are so commonplace that natives no longer bother to look up at them, and the descendants of Herodotus' "anthropophagi" (cannibals, to you) conduct decorous classes in Sunday school.

But the mystery of Africa has only been breached, not dissipated. Partial answering of some questions has only sharpened the need for finding fuller answers. Many of the most brilliant discoveries of the past two or three generations of exploration have only opened up windows on new and challenging vistas of the unknown.

Puzzling Bones

Acquaintance with Africa's many and highly varied peoples, for example, has raised questions of where they came from, how they got there, and what can be done to make their future pleasanter and more profitable for them than their immediate past. Chance scattered discoveries of fossils representing remoter antiquity of man and his relatives, like the famous Rhodesian Man skull, and more recently the puzzling bones of manlike apes in South Africa, have broadened and intensified the challenge to dig up more parts of the puzzle and piece them together into a completer picture.

Most ambitious and far-reaching acceptance of that challenge thus far is provided by the University of California African Expedition, which has undertaken a sweep over the entire continent from north to south, finding out everything possible about present peoples and about the still-unfathomed past. It has already been in the field for many months, with a staff of a score or more trained graduate workers. Its leader is Wendell Phillips, with energetic young William B. Terry as field executive. Africa's own scientists, from Egypt to the Union of South Africa, have participated in the program. Results are beginning to roll in, some of them along expected lines, others quite unlooked-for and dramatic.

One of the first regions to be examined was not properly in Africa itself, but rather upon the threshold between Africa and Asia. This is the Sinai peninsula, where the Children of Israel wandered on their way from Egypt to the Promised Land, and where Moses received the tables of the Law.

Early Wanderers

There were wanderers there long before Moses, abundant evidence showed. At Rawafi was found a site of early Old Stone Age, with several hundred almost perfect stone hand-axes right on the surface. These were of the primitive type used by Neandertal

Man. Farther to the southwest in Sinai, two more Old Stone Age sites were discovered, with implements of the same type. The presence of such large numbers of stone tools at Rawafi suggests that this was no mere campsite or temporary settlement, but a center of Stone Age industry — a kind of paleolithic Pittsburgh. These sites on Sinai are also of importance as markers on Neandertal Man's migration from his presumed original home in Asia into Africa.

Search for traces of the remote past in Egypt centered in the Faiyum, a wide lowland west of the Nile valley, that was once the bed of a vast lake. This was far back in Ice Age times, when the climate of northern Africa was rich with vegetation where it now is desert. Terraces on the sides of the dry hills mark the levels of the lake as it gradually shrank, as similar terraces in Utah and Nevada mark the stages of the vast Ice Age ancestor of the present much-shrunken Great Salt Lake.

During Egypt's great days, the Faiyum was a rich province ruled by governors of the Pharaohs, and there were elaborate irrigation works and canals. An airplane was used in scouting for the remains of these canals, now choked with desert sand. Some were found as recent as the reign of Cleopatra, Egypt's last independent monarch. Others proved to be older than any recorded dynasty on the Nile.

These earliest canals were the work of farmers of the New Stone Age, or Neolithic, when agriculture was still something new under the sun. Particularly active in finding village sites and other remains of these Egyptians who were before any Pharaoh was Dr. S. A. Huzayyin, modern Egypt's leading prehistorian.

Primitive Whales

Still older than these remains, older than any human occupation, were bones that gave evidence that what was a great lake in early human times was an arm of the sea before that. Most convincing of these bones are the remains of a primitive kind of whale known as Zeuglodon; two practically complete forty-foot skeletons of these great sea-beasts were found "chasing each other" in what the workers promptly christened Zeuglodon Valley. Other remains of aquatic animals included bones of crocodiles, turtles and hippopotamuses, belonging to the later, fresh-water phase of the region.

Ancient Teeth

The expedition is now in Kenya, where the remote, pre-human past has again come in for attention. Ape teeth of Miocene age (perhaps 40,000,000 years) have been found in the Lake Rudolf area by a South African paleontologist, Dr. Basil Cooke, and by Dr. Robert Denison of Dartmouth College.

In the meantime, measurements of the living human inhabitants are being made by an Egyptian anthropologist, Dr. Mohammed Mitwally of Farouk University in Alexandria. A colleague of his, Dr. Mohammad Awad, is studying the fossils of invertebrate animals near Mombasa.

Plans for the future of the expedition include more tropical medical research, in the Congo, British East Africa, French Equatorial Africa and Portuguese East Africa or Mozambique. A cave at Ladysmith, in the Union of South Africa, is to be excavated, and with luck should yield still further information on ancient human and sub-human life on the no-longer "Dark Continent."

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A History Of Fossil Collecting

RICHARD L. CASANOVA

Part 2
The 16th and 17th Centuries

Starting the 16th century with Conrad Gessner, we learn about the many other students of earth science, who brought the study and collecting of fossils out of the dark corners of misunderstanding and prejudice into the brightness of a renaissance of study and publication by free-thinking experimentalists and scholars.

Conrad Gessner (1516-1565) was a Swiss naturalist. In 1565 he wrote a voluminous treatise entitled "De rerum fosilum lapidum et gemmarum figuris." While Gessner was one of the first fossil-hunters to ilustrate his book with plates of fossils, he had no true conception as to the origin of these fossils, which he regarded as being either the remains of animals or productions of some inorganic process. Gessner is best remembered for his "Historia animalium," which taking 36 years to complete, filled five folio volumes with unsystematic accounts of the animal world as known in his time, as well as the many ani-his time, as well as the many animals of fable and superstition.

At Basle, in 1556, the first study of stratigraphic geology was published. Georgius Agricola (1494-1555) was the author and the title of the work was "De Re Metallica," an important book which was to form the basis for the study of all later metallurgy. Prior to this book, Agricola had written a systematic treatise on mineralogy which he called "De Natura Fossilium." Agricola was a Saxon physician and also professor of chemistry at Chemnitz, which might explain his tremendous interest in forming one of the first "cabinet" collections of fossils. So deep was his interest in collecting fossils and forming a cabinet of them (as collections of of all natural history were called), that he carefully compiled all the information he could find both from a study of earlier authors, as well as from examination of his specimens. It was the results of his studies which came forth as "De Natura Fossilium."

Agricola also has the distinction of being the first scholar to coin the term "fossil," although he used the word for anything which was dug out of the earth. With the furtherance of the earth sciences, the term came to be restricted only to prehistoric animals, with the use including ancient man by present European workers.

About 1550 Mattioli entered the stage and later wrote the first book about fossil fishes, which he had collected at Monte Bolca, Italy. Mattioli was under the impression that such porous bodies as shells and even bones could be turned into stone by being permeated with a "petrifying juice."

Falloppio (1557) and Mercarti (1674) both studied fossil invertebrates, and both regarded fossils as being stones turned into such seemingly organic shapes through the influence of celestial bodies. The curtain went up on the 17th century, and the controversy on earth science and the origin of fossils assumed greater proportions.

At this point, one of the most influential of Italy's up and coming scientists entered the conflict. Nicalas Steno (1631-1687) was born in Copenhagen. During his early youth he traveled extensively through Europe, finally settling in Florence where at the age of 36 he was appointed physician to the Grand Duke Ferdinand 2nd. During his travel in Italy, he studied the geology of Tuscany and in 1669 published a paper on the results of his study and observations. The title of this important work was "De solido intra naturaliter contento." His work included a study of minerals, fossils and the composition of crystals.

This work made such an impression on the Continent that an English printing of this book came out in 1671, under the title "The Prodomus to a Dissertation concerning Solids Naturally contained within Solids." Steno's principles on the formation of the earth created quite a stir in his day; particularly was there a rise in arms of the Diluvialists. For here in Steno's small paper was to be found the principles that "strata has been formed from matter precipitated by water, said matter falling by its own weight to the bottom and this forming a sediment."

One of the most important works to see the light of the renaissance, was Robert Hooke's (1635-1703) "Posthumous Works." For here did Hooke argue that the Deluge was not of sufficient duration "for the production and perfection of so many and full grown shells," — this in the vein of Fracastoro. Hooke went on to say that "the quantity and thickness of the beds of sand with which they are many times found mixed, do argue that there must needs be a much longer time of the seas residence above the same, than so short a space afford."

Martin Lister (1638-1712) was the first geological worker to introduce the construction of geologic maps. With regard to fossils, these he regarded as curiously shaped stones which he considered as "never (being) any part of an animal." However, in 1671, he described and illustrated "fossil-shells" with great care and with an eye to detail and even offering illustrations of recent shells for comparison. In his efforts to prove the dissimilarity between fossil and recent shells, he induced many scientists and scholars of the day to discard their Diluvialist theories. Of much greater importance was his observations upon the different strata and their fossil content. While he was not the first to observe that "'quarries of different stone (st ata) yield quite different species of shells," he was the first to put it down in a printed report. In this same report he goes on to say that "those cockle-stones (shells) of the iron-stone quarries of Adderton, in Yorkshire, differ from those found in the lead mines of the neighboring mountains, and both these from the cockle-quarrie (shell marl) of Wansford Bridge, in Northamptonshire; and all three from those to be found in the quarries about Gunthrop and Beausour "Castle." In 1683 he submitted to the Royal Society a series of "mineral maps," through which he proposed to view the correlation and stratigraphy of geological "soile and mineral."

The closing years of the 17th century were again to see the hypothesis of "Nature's sports" revived, with a letter published in 1698. .by Edward Lhuyd (1660-1709). In this letter, Lhuyd attempted to account for fossils by what he termed "seminal vapour." A translation of his theory runs as follows: "I have imagined they might be partly owing to fish

spawn received into the chinks. . . . of the Earth in the Water of the Deluges, and so be derived amongst the shelves or layers of stone, and whether the explanations which are raised out of the sea, and falling down in rains, do water the Earth to the depth here required, may not from the seminium, or spawn of marine animals be so far impregnated with animalcula as to produce these marine bodies. I imagined further that the like origin might be ascribed to the mineral leaves and branches, seeing we find they are for the most part the leaves of ferns and such like plants, whose seeds may be easily allowed to be washed down by the rain into the depth here required."

The curtain comes down on the 17th century with the publication of one of the most important books to be printed up to this point in our history of earth science. John Woodward (1665-1728) was professor of Physic at Cambridge. Not only was he the greatest collector of fossils and minerals of his age, but he took such an active interest in the field that he founded a professorship in geology at Gresham College.

The England of his day took such notice of his participation in the fossil collecting field that many poems and broadsides were written about him. One of the great farces of the day written about him, entitled "Dr. Fossile, the Man who has the Raree-Show of Oyster-shells and Pubble-stones," was a great success on the stage. The literary work which he published in 1695 was to place him among the immortals of earth science history. Its title was an "Essay toward a Natural History of the Earth and Terrestrial Bodies, especially minerals, as also of the sea, rivers, and springs, with an account of the Universal Deluge, and of the effects that it had upon the Earth." The theory he promulgated in this long work stated that a great reservoir of sub-surface water on bursting forth, mixed all forms of organic and inorganic matter, which, mingling with sediments settled in the order of their weight; thus, fossils being among the heavy substances, forming the lowest layers and so on. Woodward's collections of fossils are still on exhibition at Cambridge, and the Woodwardian Professorship is eagerly sought by aspiring geologists.

Thus we close this chapter on the "Early Fossil-Hunters." The next article will survey the "Birth of Paleontology" as a science and bring upon the stage of earth science history the great men of the 18th and 19th centuries who gave fossil-study a new life, and an understanding of the first principles of evolution and life upon earth eons of time ago.

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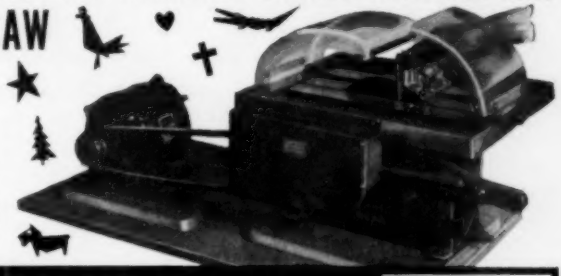

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